

1st in sheet
International Health Exhibition,

LONDON, 1884.

THE

PARASITES OF MEAT

AND

PREPARED FLESH FOOD.

TWO LECTURES

ILLUSTRATED WITH TEN WOODCUTS,

TOGETHER WITH AN

APPENDIX

CONTAINING A DESCRIPTIVE CATALOGUE OF ONE HUNDRED
DRAWINGS OF PARASITES EXHIBITED IN THE SOUTH
GALLERY, CLASS VIII., No. 206.

BY

T. SPENCER COBBOLD, M.D., F.R.S.,

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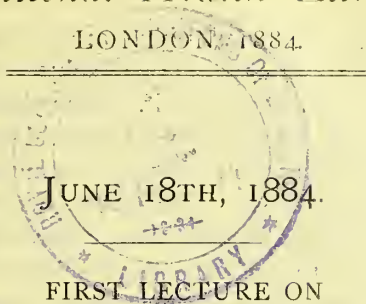
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FIRST LECTURE ON

PARASITES OF MEAT AND PREPARED FLESH FOOD.

By Dr. COBBOLD, F.R.S.

SIR JOSEPH LISTER, Bart., F.R.S., in the Chair.

I HAVE the honour to introduce to your notice this afternoon a subject of high importance in relation to the public health, a subject too often disregarded on account of its supposed unpleasantness, but that is a prejudice which is entirely misplaced. In order to profit by these studies, it is important that we should dispossess ourselves of all preconceived opinions, and approach the subject in an attitude of simplicity, with an anxious desire to ascertain the truth; for unless the mind be absolutely free and unbiased it is impossible to deduce conclusions which shall have substantial and practical value.

This afternoon I propose to deal with a group of little creatures, which we may call earthworm-like parasites, because they happen to have the form and configuration of earthworms. They are for the most part minute. Especially is this the case with the *trichina spiralis*, which will occupy a considerable part of our time. Now in the little *trichina* you have an admirable example of a parasite which is *directly* injurious to man, and I hope before the close of the lecture to be able to find time to say a few words

about other little creatures, which are *indirectly* injurious to man. We can best approach this subject by explaining the origin of our knowledge of it. Nearly fifty years ago, in 1835, a student engaged in anatomical studies in one of our metropolitan schools observed in human muscles a number of minute specks. These specks excited his attention, and being more earnest than others of his fellows, he went off to see the celebrated botanist Robert Brown, who possessed a microscope, which was a scarce thing in those days. By means of that microscope he succeeded in extracting from one of these little specks a minute creature. He immediately sent specimens far and wide, and certain of them were sent to the already distinguished zoologist Professor Owen. Professor Owen published an elaborate memoir in the Zoological Society's Transactions, in which he described this little creature, and called it *trichina spiralis*, a name which must be retained. Hence arose not unnaturally the persuasion on the part of many abroad as well as at home that Professor Owen had actually discovered the worm, and nine persons out of every ten whom we meet still entertain that opinion; it is however the fact, that the parasite was discovered by the present Vice-Chairman of the Executive Committee of the International Health Exhibition, Sir James Paget. I am happy to have been instrumental by careful search into this question in convincing many of the later foreign writers on this point. Previous published statements, especially in Germany, were certainly wrong. It is not often Germans make mistakes, but here they were misled. Thus, in the work of M. Chatin, in the recent United States Report by Dr. Glazier, and in other standard works it is at length acknowledged that the discovery of trichina lay with Sir James Paget. But little did these early investigators imagine that the tiny worm was destined to play so important a rôle in questions of hygiene, of public health, and of state medicine. Indeed, it may be said that even now we should not be in a position to know the full value of these earlier discoveries, had it not been for the subse-

quent discoveries made by other workers, more particularly by Professor Zenker, who found these little creatures in the act of migration in the human frame, and was the first to demonstrate that they gave rise to serious disease. Science is also indebted more particularly to Professor Virchow, who by his physiological experiments, by his worm-feedings, first of all on a dog, proved to demonstration whence these creatures come, and whither they go. He reared the full grown worm in 1859. The whole course of development was thus worked out by a series of helminthologists, or workers amongst parasites, and by their joint labours we have now arrived at a positively exhaustive knowledge of the history of the development of this minute organism. But here it occurs to me to remark that if some of those well-intentioned individuals who would put a stop to all experimental researches, because they involve cruelty to a few animals, knew and could realise the horrible sufferings, entailed upon those persons who have eaten meat containing these parasites—if they could, I say, witness these sufferings—they would think twice before they again tried to put a stop to those researches by means of legislative interference. Experiments have already been of immense service in regard to the checking of disease. Further investigations, moreover, may yet enable us to stamp out some of the known parasitic disorders, which I do not exaggerate when I say that they afflict not merely hundreds of thousands, but millions of the human race.

I can best, perhaps, make known to you the position in which we are in this relation, if in the first instance I point to the diagrams on the wall. Here are two of the six sheets which I prepared during



FIG. I.—*Trichina spiralis*; male, full grown. After Leuckart.

the winter for this Exhibition, and the first one shows the development of the trichina. Fig. 2 shows these specks enlarged; there are little



FIG. 2.—*Trichina spiralis*; larva coiled within its capsule. After Bristowe and Rainey.

lemon-shaped particles, and in the interior of each of those is a single worm coiled up, as is indicated by the circular figure at the upper part of the diagram. This is the condition of things which Sir James Paget discovered in the subject to which I have alluded, and to give you an idea how numerous the capsules are, I have here a little piece of human muscle, which I put up some twenty years ago. It is not very thickly infested, but yet if you were to take the trouble to count the number of these capsules, even in this square inch, flattened by the covered glass, you would be able to count upwards of a hundred. But that is a very small number. Please to observe that the trichina, as ordinarily known, has a lemon-shaped form. In the diagram you will see that I have two apparently large worms represented, because they are magnified about one thousand eight hundred

times. They are the adult or sexually mature forms of the trichina, the male being to the left, and the female to

the right. What is the size of those specks? About one-eightieth of an inch long only. The little parasites inside the specks are about the one-twenty-fifth of an inch in length. But what of the full grown creature? The male is one-eighteenth of an inch in length; the female being very much larger; she is one-eighth of an inch in length, but that is a creature of gigantic proportions compared with many of the parasitic organisms with which we have to deal.

Now, having explained to you the ordinary appearances in flesh presented by the trichinæ, it will be easy to make

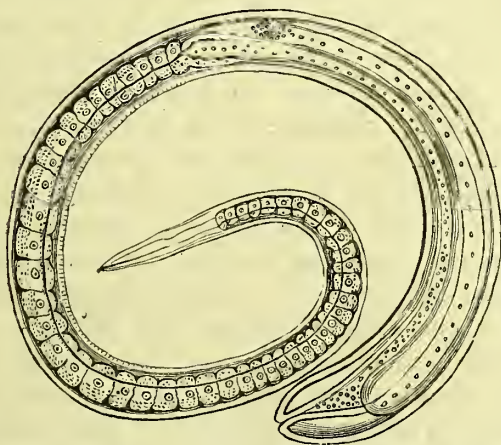


FIG. 3.—*Trichina spiralis*; young female, or complete larva, from muscle.
After Leuckart.

clear to you the life history of the creature; but before I do so, please to observe that I have enlarged some of the little specks to an immense size. Here you will observe a mal-formed capsule, not of the ordinary lemon shape, and inside this double capsule there are several parasites rolled up. Such capsules are called poly-trichinous, five, six, or even seven worms being sometimes found in one capsule. These malformed specimens are copied from a recent work by M. Chatin, who has been largely investigating this meat question in France. These are from American pork. What

happens is this:—Supposing you and I indulge ourselves by eating underdone trichinous pork; these little capsules—if there be capsules present, for they are not essential by any means—are digested. Two days (forty-eight hours) after we have swallowed these specks, the little creature becomes matured; it has grown into a full sexually mature worm. There are, in short, males and females. In another six days the eggs and their living contents (which you see there represented on a very large scale) escape in prodigious numbers, myriads, tens of thousands, and they proceed immediately to pass through the walls of the alimentary canal. They stop at nothing except hard bone, and they freely penetrate all those muscles which are nearest to the viscera, those of the thorax and abdomen especially becoming largely infested. In fourteen days more they have acquired the complete larval form, such as is shown in the diagram, and capsules are commencing to form around them. What happens as a consequence of this? You will have five or ten, fifteen or twenty, or for that matter you may have one hundred millions of these little creatures as the result of a single feeding. Let us be modest in our calculations, say ten millions of these creatures are perforating the muscles, groping their way in order to find a resting-place in the host, that is to say, our frames. The wounds inflicted by these little Lilliputian creatures when collectively considered are sufficient to produce the most distressing symptoms and agonising pains, besides a variety of other phenomena upon which it is quite unnecessary for us to dwell. Here then we have a disorder arising directly from the consumption of meat containing these little trichinæ or specks.

Having explained to you the injurious effects which thus arise, I shall now proceed to speak of certain epidemics. Here let me throw out a general hint that parasites are obnoxious, or distressing to individuals, as a rule only when they occur in great numbers. You understand, it is a question of overcrowding. As distress arises in a city from the overcrowding of its human occupants, so distress arises

in the human territory itself, when it is overcrowded with Lilliputian inhabitants of this description. Now you are aware that we have what are called epidemics or outbreaks, due to the consumption of these parasites. Let me refer to a few figures here, because it is desirable to be absolutely accurate. I only go to the most recently published memoirs that I have received within the last few days from Germany, and I find that the latest calculations with regard to these epidemics have been made by Dr. Wurtz. According to Wurtz they have had thirty-three epidemics on the continent, and these epidemics involved one thousand seven hundred and eighty-six sufferers; of this number only one hundred and seventy-three died. You will please further observe in this connection, that out of thirty-three epidemics no less than twenty-five were distinctly traceable to home-fed swine slaughtered in the Fatherland, and two others of the thirty-three were due to the consumption of the meat of forest animals—boars; the other outbreaks were not traced to their sources. Now you are aware that quite recently we have had an outcry against the consumption of American pork. Why? It has been found that about eight per cent of American hogs contain trichina, and those persons, it is said, who eat of this pork will suffer. But it must be some satisfaction to you to be told authoritatively that no single case of trichinosis in the human subject has been traced to the consumption of American pork on the continent, and further it will be interesting to you to know, if you do not already know it, that M. Colin has instituted experiments, and has shown that you cannot give an animal trichinosis, even if you feed it with imported American pork known to contain trichina. Why is this? It is because all the trichinæ found in the salted pork sent over from America to this country, to France, and to Germany, are dead. Salting destroys trichinæ, if it is only sufficiently prolonged.

So much for foreign outbreaks, but what about the outbreaks in this country? Have there been any true out-

breaks of trichinosis in the United Kingdom? If you were to believe what has been written, you would say, oh yes, many instances! Permit me to say that there has been only one genuine outbreak of trichinosis, and that occurred in Cumberland, and was witnessed by Dr. Dickinson. That gentleman was good enough to send specimens of the pork of the home-fed animal, which had been eaten by the family, where the disorder occurred, for my inspection, and I found abundant specimens of trichinæ in it. Now, there is but this one solitary instance, full particulars of which have been placed on record in the Journal of the Society of Arts, as I gave them in a course of Cantor Lectures, which I delivered there some ten or twelve years ago. I need not say more, therefore, on the point. But you will say, have we not heard that there was an outbreak of trichinosis on board the Government Training Ship, "Cornwall," and have we not heard that there was another outbreak from eating sausages at Thaxstead, in Essex? Yes, you have, but neither the one nor the other was a case of trichinosis at all. It is very unpleasant ever to have to correct the errors of other persons, but where one has the interest of the community at heart, and where one above all things is desirous that the truth only should be eliminated, in all such instances one must take upon oneself, after thirty years' toil in this subject, the prerogative of venturing to differ from authorities, who do not happen to have paid any attention to the subject, but yet have pronounced such cases to be trichinosis. Take the case of the "Cornwall," in 1879. It was said that a lad died of this disease on board the "Cornwall," and that a great many others were affected with trichinosis. A young gentleman connected with the Local Government Board made what he thought was a discovery, and so it was a discovery, but unfortunately it was stated to be trichinosis. It was not until five months after this outbreak occurred, which was in September, 1879, that we were favoured with the Government report, and I can state that if the specimens of this alleged trichina had been forwarded to any of us who have any acquaintance with

the first rudiments of helminthology, we could have settled the question in five minutes. However, we waited patiently for five months, and at length we got the Government report, of which I have a copy in my pocket. I will read the title of it. Here is the report, and you will observe that it is in the usual official Blue Book form. It says, "Report on an outbreak of fever, which proved to be trichinosis, on board the training ship, 'Cornwall.'" This was an unfortunate title, because it was not trichinosis at all. That was issued on March 15th, 1880, and very shortly afterwards I wrote to the 'Times' newspaper, stating that the little parasite in question was a totally different creature. I called it a rhabditiform worm—that is a little creature which bears some resemblance to a trichina. If we were to go into the matter scientifically I should be able to convince you that it really had scarcely anything in common with the trichina. Now the mischief did not end there, as my letter to the 'Times' brought down on me a wrathful literary castigation, which I am happy to say I have survived. Unfortunately the certain foreign journals, including the New York Medical paper, all followed suit, and reported this as trichinosis. It is really painful to point out these errors, but is it not one's duty? That was the question which presented itself to me, and so the matter was further investigated, and we now all know what the creature was.* It is called *Leptodera teres*. But another outbreak of trichinosis was said to have occurred in 1879 at Thaxstead, in Essex. Unquestionably there was great distress, there was poisoning from eating sausages, and with light heartedness it was at once pronounced to be trichinosis by those who were not really acquainted with the subject. But there was not a single trichina found in that instance, nor any parasite whatever in the sausages. The outbreak was

* In a paper communicated to the Quekett Microscopical Club (of which I was at the time acting as President) I designated the worm *Rhabditis Cornwalli*, but it has since been shown by Dr. L. Oerley that this rhabditiform worm is the same as that described by Schneider, of Berlin, as the *Leptodera teres*.—T. S. C.

due to sausage poisoning, the result of decomposition ; for there is a peculiar organic compound formed in putrid sausages, which gives rise to a disease, which has been well described on the continent, and it is called *botalismus*. And here let me remark by the way that we are constantly hearing of cases of poisoning from putrid meat, and putrid animal foods of various kinds. Only yesterday evening I read of two deaths from eating tinned salmon in Wolverhampton, as reported in the Pall Mall Gazette. This was a case of disease, due to decomposition and the formation of a poisonous compound in the flesh, consequent upon an opening occurring in the tin, which let in the air, and caused the state of things that resulted in the death of two persons. There are a vast number of little creatures apt to be mistaken for trichina by those who have not studied the subject properly. Some of you may remember that we were favoured a little while ago with accounts of the so-called tunnel trichinosis affecting the labourers in the St. Gothard tunnel, when it was being constructed. That was a disorder due to a parasite, which has very little in common with the trichina, although it was called "tunnel trichinosis." Here is a representation of the parasite, the ancylostomum ; thus, the disease ought to have been called ancylostomosis instead of trichinosis, which is a totally distinct disorder.

We have also had numbers of animals every now and then swept off by disorders which are put down to trichinosis, although the diseases in question have no sort of connection with the subject. If you could realise the numbers of communications one receives asking anxious questions on this subject, you would get a notion of the confusion that exists in the minds of the public generally upon this subject. Trichinæ have been discovered in the pike, in the eel, in mackerel, and in this, that, and the other fish—supposed trichinæ, not one of which has any genetic relation whatever with that dangerous parasite. These have been described as genuine cases of trichinæ, and it may be some satisfaction to those of you who are fond of

fish to know that with regard to these little filaræ (these little earthworm-like creatures of which you see an enormous number sometimes in fish that are brought to table), you may swallow any amount of them you please, cooked or uncooked, and no harm can possibly result. I do not say that every parasite in fish is harmless ; it does so happen that there are one or two which are not so ; but you need pay no regard to these, as they are extremely rare. I was once called upon to give an opinion upon a supposed outbreak of trichinosis near the mouth of the Thames, where a family were severely affected ; and, curiously enough, their domestic cat died from what they supposed to be the same disease. I examined the cat, and found it had died of a parasite very like the trichina in its behaviour. It was a totally different parasite, namely, *gylanus*. The disease, therefore, which sweeps off cats is *olulanosis*, not trichinosis. Swarms of animals are carried off by these and other destructive little organisms, and the diseases are set down to wrong causes by persons who have not acquainted themselves with all the multitudinous intricacies and nice distinctions which abound in this really complicated and extraordinary subject.

Now we come to another aspect of this question, and that is prevention. How shall we prevent any harm arising from these affections ? It is easy enough. Years ago I instituted a few experiments, and Dr. Timothy Richard Lewis did the same in Calcutta, with the view of determining this point, and we came to the conclusion that trichinæ submitted to a heat of 140° Fahrenheit, would be killed. In this way we ascertained that meat comparatively underdone would be pretty safe, though raw meat, of course, would not be so. But our experiments were rough and poor compared with some recently instituted by Professor Perroncito of Turin. Those temperature-experiments were made with extreme care, and he found, greatly to our satisfaction, that 48° Cent. (which is rather less than 120° Fahr.) is sufficient to kill the trichina. There is, therefore, absolutely no reason why anyone should have

this disorder if only they will take care to have their meat tolerably well cooked. Some very interesting experiments were made by M. Colin lately, with regard to the American pork question, and he finds that two or three days' salting is sufficient to kill all those creatures which lie near the surface of the salted meat, although in large masses of meat it would take two or three months, or even more, for the brine to soak in deep enough to kill those parasites that lie in the centre of such a large mass. All the trichinous meat sent from America that has been examined, has been found to contain dead parasites only. Next comes a question of practical importance in regard to meat inspection. One fact only have I time to name, and I think you will regard it as of interest. You know that in Germany meat inspectors are appointed especially for the purpose of looking after trichina, and recently a Berlin correspondent wrote in one of our medical journals, that of 154 pigs, the carcasses of which were ordered to be destroyed, 14 were so because they contained trichina; but 140 were destroyed because they contained measles. Please not to mix up the idea of "measles" as having anything to do with the disease of children which goes by that name. This is something totally different. I am not going to say a word this afternoon about measles; but I hope at my next lecture to show you some of these things, and to explain to you their importance in relation to this question. Meanwhile, I have only one more remark to make on this subject. Notwithstanding the remarkable precision and the infinite pains-taking exercised by the German inspectors in this matter, only the other day there appeared an article in a German medical journal by a Dr. Pütz, who really disputes the efficacy of the work done by these inspectors. He admits that a vast number of cases are found out by them; but he holds that sufficient and adequate protection is not afforded in spite of all these precautions. It seems strange, but it shows that in spite of every care there are always some little points which remain to be explored.

I have dealt thus at length with the trichina, not merely

on account of the intrinsic interest attaching to the subject itself, but because, by this simple exposition of the facts of trichinosis, I shall be able in the few words that remain to me to explain more clearly the phenomena undergone by other parasites which do not *directly* injure us. Those parasites which *indirectly* affect us are of great importance, because they sweep off our flocks and herds sometimes in prodigious numbers, involving the loss in a single season of perhaps two millions pounds worth of food. These creatures are allied to the trichina to the extent that they belong to the same group of which we are speaking to-day, namely, the little earthworm-like parasites. Most of you have heard of these outbreaks—cattle, sheep, swine and deer dying by scores, not to say by hundreds, from parasitic affections of the lungs. In this way the farmer suffers great loss, and we ourselves suffer in consequence of the increased expense of food; the entire community being more or less affected by these destructive outbreaks. Now, the parasitic lung affections are generally all rolled into one, commonly called the “husk” or filaria disease. We need not be very careful about scientific names here; but let me inform those who have not looked into this matter, that in place of one filaria causing the destruction of sheep, there are four different kinds of filaria, earthworm-like creatures, or round worms concerned, let alone other parasites of which we do not speak. On the diagram, I have endeavoured, with the aid of a young lady who has constructed two of those drawings for me, to give an outline of the structure of these four kinds of parasites. I had better give them some English names, which they have never yet received. On the sheet you see some twenty-nine drawings—Figs. 1 to 5 refer to what I call the common lung-worm of the sheep—6 and 7 may be called the red-tinted lung-worm; the scientific name for the first, is *Strongylus filaria*, the second *Strongylus rufescens*; the first is about 3 inches long, and the next is nearly 7 inches long when full grown. Then we have the third group, Figs. 8 to 16 inclusive, *Strongylus paradoxus*—you may call it the puzzling or paradoxical

lung-worm ; and lastly, all the remaining figures, 17 to 29 inclusive, refer to a very remarkable little parasite, which occurs also in the lungs, which you may call the hair-like lung-worm. You will observe two highly coloured figures ; the one below represents a sheep's lung with certain tumours on the surface, in which are rolled up numerous little parasites. This little hair-like parasite bears the scientific name of *pseudalius ovis pulmonalis*. It is a marvellous creature. Let me try in a few words to describe it. You see a little circle, Fig. 18, representing the worm as if placed under the cover of a microscope slide. Although you see only a little tiny dot marked there, the parasite as I have drawn it is actually magnified 100 times. The head and the spirally coiled tail is represented in Fig. 19, magnified 11,000 times. I could not give you the whole figure, of course, because if you were to uncoil this little creature to the full extent, so magnified it would be very much longer than this room ; the drawing would be 30 yards in length. But, notwithstanding the exceedingly minute size of this parasite, it produces disease of the lungs, and is almost as destructive as the *Strongylus filaria* or common lung-worm, which carries off many of the animals of our country. The best way, perhaps, of conveying some idea of the actual size of this creature is this :—If you cut off one inch of a hair from your head, take the hair and split it up into five divisions, each of those divisions would practically represent the creature, when unrolled, in its normal size. It is one inch long, but it is so constantly rolled upon itself, that it looks like a fine speck under the microscope ; it is delicate and transparent like the finest glass ; but nevertheless the female is full of eggs, and these eggs are of excessive minuteness. Two of them are figured here, Figs. 22 and 23. To make it at all visible, I have been obliged to magnify the egg 50,000 diameters. Now, Mr. Alois Koch, of Vienna—no relation to the Koch of *Bacillus* fame, whose name our Chairman is so familiar with, having himself antecedently and successfully worked in the same direction before Koch's fame was established—has

published a beautiful memoir on this parasite, but I cannot dwell upon it.* The *Strongylus filaria*, is the parasite which is so destructive to animals in this country. The *Pseudalius* is also found here, for I myself years ago encountered it. Now, please to observe further that every one of these parasites, and hundreds of others which we have no time to speak of, has to go through a course of development, precisely in harmony in all its main features, with what I have described to you as occurring in the case of *Trichina spiralis*. Every worm requires a change of hosts. It must pass from the human territory to an animal in order to complete its life cycle, or cycle of development. Has anyone worked out the development of these lung parasites, which are destroying our flocks and herds by thousands? Has any money been advanced by any society in this wealthy country for any one to carry out these researches? Not one single penny. It is true that the Royal Agricultural Society has done great service by securing the researches of an able man, Professor A. P. Thomas, lately Professor Rolleston's assistant at Oxford, who worked out the history and development of another totally distinct parasite, which gives rise to the rot in sheep; but that has nothing to do with this series of entozoa. Here are parasites as destructive as the rot-producing fluke and not one single investigation that I am aware of has been made, either in this country or abroad, with regard to their development. We want encouragement in these matters. Years ago an Agricultural Society in England actually did me the honour to keep me in correspondence for three weeks on the subject; but to be candid, when I stated to this wealthy society that the report of the investigation, to be of any value whatever, would cost them £100, I never received another communication from them, and thus the whole thing fell through. However, nothing daunted, I

* Herr Alois Koch's memoir, "Die Nematoden der Schaflunge," was originally published in the "Revue für Thierheilkund und Thierzucht," but it may be obtained separately of the publisher; Wien; Alserstrasse 32.—T. S. C.

determined if I could find a little time to work out the matter independently. Let me explain what I attempted. I worked on a parasite very like the *Strongylus filaria*, and it is one that lives in calves, being destructive to young cattle. It is the *Strongylus micrurus*. I will tell you what I did. I took from one of the bronchial tubes of a calf a number of the parasites; the females are about three inches long. From those I removed the eggs with their contained *larvæ* or *embryos*. I then took the embryos and placed them in some very finely sifted earth, and then I put the earth in watch glasses beneath a bell jar, under which were some ferns growing. By-and-by an earth worm gained access to one of these little watch glasses. I then examined carefully from day to day the little creatures inside the earth, but they underwent no change of organisation—no perceptible change; but I found when I slit the tail of the worm off—an operation which any gardener performs every day, and is not sent to prison for so doing—that the little parasite that had got inside the alimentary canal of the earthworm had undergone a change, had increased in organisation. I, therefore, recognised a further stage, and I could report progress. I then took these little creatures—I had only a few from this earth-worm—and I placed those which had advanced thus far on the dew drops on the fern under the bell jar, and then to my astonishment and delight, the activity of these creatures became strongly pronounced. They rushed about frantically to and fro, they increased in size and organisation, and, to cut a long matter short, by-and-bye I found that they attained the form in which I could observe distinctions of sex, and could already recognise males and females. Thus far, therefore, that single experiment seemed to be useful. I had not enough to complete the whole cycle. Please to observe that these facts, as far as they go—I do not wish to place any undue stress upon them—may be useful as a guide to others who will in future undertake these experiments. Let us now deal with the facts which agriculturists tell us about their flocks. Here is a curious and interesting point; Mr.

Beulah, a farmer at Brigg, in Lincolnshire (the only farmer I was ever acquainted with who was familiar with the use of the microscope) in a paper read before the Quekett Club, of which I was President at the time, stated some very interesting facts, which I think you will see harmonise with the results obtained by my single experiment. He had a flock of seventy-two sheep, seventy of which were turned into a meadow on one particular day; eight days after those sheep were all affected with the so-called husk or parasitic bronchitis, or parasitic pneumonia, call it what you will; and every one of them died. Two of the sheep were not allowed to enter the meadow, and they remained perfectly well. They did not graze there, and they did not take the disease. Clearly here was a case where the animals had contracted disease by feeding in a particular meadow. Now Mr. Beulah, like a sensible microscopist, went into the meadow, took up some of the grass and placed the dew of that grass, the moisture of the herbage, under the microscope, and he found that dew swarming with little creatures, little microscopic round worms, earth worm-like creatures, which from his statement appeared to correspond in almost every particular with those I had reared on the fern leaves under the bell jar. Putting, therefore, two and two together, I think we have made out a good case for further research.

I will only add in this connection that the parasite *Strongylus filaria*, of which I hold a female specimen in my hand, is estimated by Mr. Beulah to contain—he counted them—three hundred thousand eggs containing young worms or embryos in its interior. Therefore, imagine if you can, for a single moment, the enormous amount of egg distribution which occurs from a flock of sheep carrying ten and hundreds of thousands of these adult parasites, every one of which gives forth three hundred thousand little lung parasites.

I will add one word more only, and that is this. If you cannot call these studies about parasites either beautiful or good, you must at least admit that they are true, and whatever leads to the enunciation of truth must in the long run

be of benefit to the human race. Were you even to cast aside all utilitarian aims, all questions of public health, pounds, shillings and pence, and such like matters, there yet remains for those of us who devote our entire lives to these studies, those satisfactions, those experiences, those delights, which every cultured mind experiences when it is made the recipient of the inrush of new ideas, new conceptions, new convictions, and new knowledge in every form, based upon personal, continuous, unhasting and unresting scientific labour and research.

The Chairman, in proposing a vote of thanks to Dr. Cobbold, said it must be very satisfactory to them, and to the public also who would read the lecture, to hear on his high authority, that the much dreaded trichinosis could be so easily warded off, and that this disease, which had so much exercised the minds of our neighbours on the other side of the channel, was in reality never produced by American pork. He could easily understand that some, while admitting the importance of these studies, might be inclined to commiserate the Doctor on account of their repulsiveness. Those, however, who had witnessed the enthusiasm with which he had described some of his own researches, would feel that Dr. Cobbold stood in no need of commiseration. They would understand how even the most unpleasant and the most repulsive objects in nature became invested with the most intense interest when investigated by the light of science. They might be sure, therefore, that Dr. Cobbold in every fresh discovery he had made had experienced the most intense intellectual pleasure, whilst at the same time he felt that he was labouring for the good of his fellow creatures.

JUNE 25TH, 1884.

SECOND LECTURE ON
PARASITES OF MEAT AND PREPARED
FLESH FOOD.

By Dr. COBBOLD, F.R.S.

Sir LYON PLAYFAIR, F.R.S., K.C.B., in the Chair.

THOSE of you who were present at my previous lecture will remember that we dealt with a group of parasites, earthworm-like in form, and I sought to show you how these minute organisms were directly on the one hand, and indirectly on the other hand, injurious to man and beast. This afternoon I have to direct your attention to an entirely different group of creatures, more formidable in appearance and in some quarters of the globe, at least, even more destructive to human life. I allude to those singular parasites which are commonly called tape-worms and bladder-worms. The full grown worms are so-called because they have for the most part a tapeworm-like form. Those that are round and bladder-like are the larval condition of the long creatures called tapeworms; but amongst scientific persons they receive a variety of names, some few of which we cannot escape using. Thus we speak of measles, which have nothing to do with the disease commonly so-called; but they are little vesicles, or small bladder worms, and we speak of the larger ones as hydatids, which are well known to those distinguished surgeons whom I see present.

Now, it is important to observe that meat is oftentimes sent to market containing these creatures. Beef and veal, pork and even mutton, are liable to contain one or other of them. Even venison is not free. All kinds of venison may contain certain of these worms, and I have myself removed specimens of larval tapeworms from the flesh of the giraffe. I mention this because, although we do not obtain giraffe often as food, I have myself dined off giraffe, and can testify that its flesh is exceedingly delicate and nutritious. Some, perhaps, will say, why speak to us of these creatures which we are inclined to regard with a feeling of aversion? For the best of all reasons, because experience has taught us that when we bring the light of science to bear on natural phenomena, which for the untutored and barbaric mind produce something like a feeling of horror all that savours of mystery quickly evaporates. As ghosts which are creations of the imagination disappear by ordinary candle-light, so the horror attaching to these things disappears when the torch of science is brought to bear upon them. It is in the scientific attitude that we must approach this subject; and let me, at the very outset, say that, but for experimental researches conducted on various animals, no good could have resulted from helminthic studies. Our feeding and other experiments, not necessarily involving vivisection (as the Chairman who has so well advocated our cause and labours in the House of Parliament well knows) form a necessary means of combating disease. It is on such grounds that we instead of hiding our heads, ostrich-like, when the enemy appears, think it a better policy, and a more ennobling one, to face the facts, to deduce our conclusions, and if possible, to stamp out the disorders arising from the action of parasites.

With these introductory remarks, I have to ask your kind attention to some of the more patent and obvious facts which meet those of us who look for these things in every day life. Three parasites especially concern us, one which is called the beef tapeworm, because it arises from

the consumption of beef, another the pork tapeworm, because it arises from the consumption of pork, another, the hydatid-forming tapeworm, because in the larval or immature condition it forms large vesicles called hydatids. Most singular and most interesting are the facts of development in connection with these creatures. They may appear to

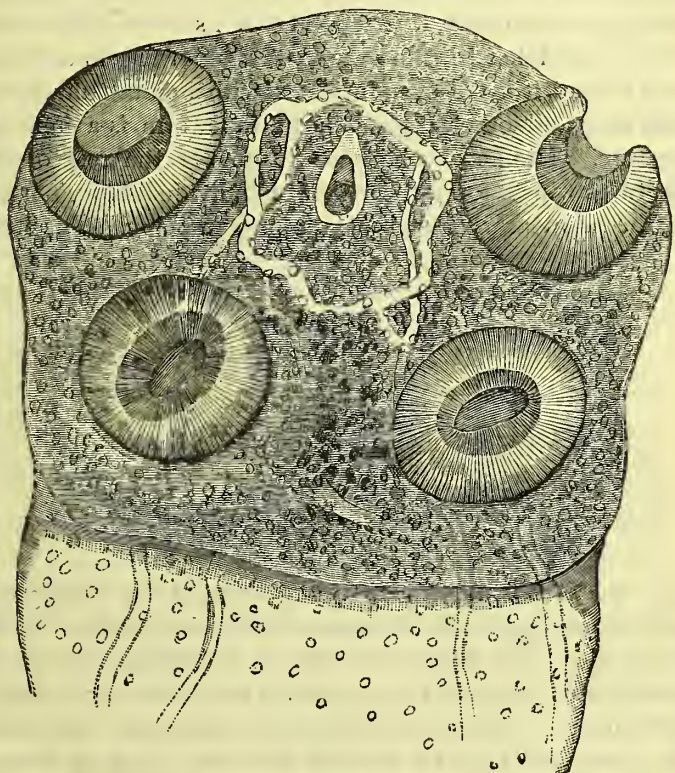


FIG. 4.—Head of the beef-tapeworm (*Tania mediocanellata*). Original.

some uninviting; but the phenomena of tapeworm development are in strict harmony with the facts observed by biologists amongst the more beautiful creatures known as compound medusæ or colony-forming jelly-fishes, which float on the ocean and attract every eye of those who cross the meridian to visit foreign lands. Please to observe

the characters of this beef tapeworm. Here is a photograph of the natural size of a specimen, which is 24 feet in length, and by no means an exceedingly long worm. The so-called head is succeeded by a long neck and chain of segments together forming the so-called body. We cannot help people calling things by misnomers, by terms which convey wrong ideas and false conceptions of the true economy of these beings, and, therefore, it is needful that I should explain that the so-called head is not a head, it has nothing in common with a head, it is not even furnished with a mouth, much less with eyes and other organs. The tapeworm is a multiple creature. The head is adapted to anchor the rest of the creatures which form the chain of individuals to a portion of the alimentary canal of the human being. The head



FIG. 5.—Group of zoöids or free proglottides of *Tania mediocanellata*.
After Leuckart. Natural size.

is a holdfast comparable to the float of the Portuguese man-o'-war, one of the compound medusæ of which I spoke of just now. The tapeworm, which is an enlargement of this photograph, comprises 1,250 zoöids, that is to say, separate individuals. They are arranged in single-file one below the other, and they all bud off from the head in succession, until in the course of two months the entire colony is formed. When it is perfect, each separate zoöid or individual passes off from the colony or chain of individuals, or goes about on its own account, passing a sort, semi-independent life in the outer world.

Please to observe what all this means. Any one of the links, 1,250 in number, contains at one time, when perfect, fully 30,000 eggs. The 1,250 are re-formed, to use round

numbers, every two months, and the human bearer of this creature is thus made involuntarily to distribute *per vias naturales*, eggs to the number every year, of upwards of 180 millions. It has been calculated—not by me—that 40,000 persons in London have the privilege, shall I say, of playing the rôle of host to these unbidden guests, because they persist in eating the roast beef of old England in an uncooked or underdone condition. That means, if you please, and I have taken some care not to exaggerate—the escape of 7 billions of germs in the form of eggs into the sewers, and if fresh sewage is distributed over the earth's surface, over our pastures, and fields, and meadows, all the cattle grazing in such infected localities, may get that parasite, and the result is, that in three months after such grazing, they have a condition of muscles such as you see figured in the diagram. It represents the left hind-quarter of a calf in which I reared these creatures by experiment. Here are some specimens on the table, which anyone can examine for himself, to see if the illustration is correct. Now please to observe these creatures are scattered broadcast, and they are so numerous in India, where they abound far more than they do here, that we may find in a single pound of flesh measles enough to give the tapeworm-parasite to half a regiment. This results from the habits of the people. I see present a medical gentleman from India who sent me specimens from an animal slaughtered in the Punjab for rations, 1 lb. of whose flesh from the psoas region contained no less than three hundred of the larvæ. There were measles or cysticerci enough to infect half a regiment, supposing each man only swallowed one tapeworm-larva. Please to observe what we have done in order to make this matter clear. You must not imagine that our neighbours on the Continent have done all the experimental work. Permit me to say, without egotism, that I have performed more experiments with the beef-tapeworm than anyone on the Continent, in fact, as many as all of them put together. These experiments were performed before recent legislation dealt with the question of cruelty to

animals. I have not repeated them since. What happened was this. I took some of the segments and fed a calf with them. When these eggs, say 30,000 to the segment, are conveyed to the stomach of the animal, they are liberated, and the gastric-juice acting upon their remarkably thick shells, dissolves them. The egg is exceedingly minute, only about $\frac{1}{800}$ of an inch in diameter. Out of the shell escapes a little creature with six hooks, two in the centre to dig with, and two pairs, one at each side, to tear with, and when these embryos are liberated in the stomach of the animal, they go on their migratory journeys. They pierce directly the walls of the alimentary canal, and make their way to the muscles. When they have got there they probably feel very comfortable and take a more or less prolonged rest. Whilst the young parasites are at ease, it is quite true that the host has been suffering. If a very large number have been swallowed by an animal, he feels a certain amount of irritation but the disease very rarely terminates fatally. When he recovers himself, which is usually the case, if you examine the flesh a few months afterwards you may find in one muscle alone, of the slaughtered animal, as many as 120 measles at the surface. Now if that animal had been sold to a butcher, sent out by him to different customers, anyone swallowing one of these larvæ is likely to contract a tapeworm. If he partakes of the meat in an uncooked condition, he will have this creature develop within him in less than three months—in two months, or say ten weeks. You will observe that the measles, which is called *Cysticercus bovis*, has a head furnished with four suckers and a little rudimentary fifth sucker by which it is destined to hold fast to the intestine. The measles is of no use to the ox or calf; but when it is liberated, and when it passes, with the beef which we eat, into our own stomachs, and the cyst is digested, then it fastens itself a few inches below the pylorus, and develops into a long tapeworm. We could not by any possibility have known of these facts, unless we had indulged in experiments, which have thus enabled us to point out whence these

creatures come and whither they go. We have yet to see how they are to be avoided. Another fact only I notice in this connection. I have here figured the heart of a calf experimented upon, and you will observe that the substance of the wall of the heart itself is swarming with these creatures. We might almost imagine that the great Shakespeare himself must have been acquainted with parasites,

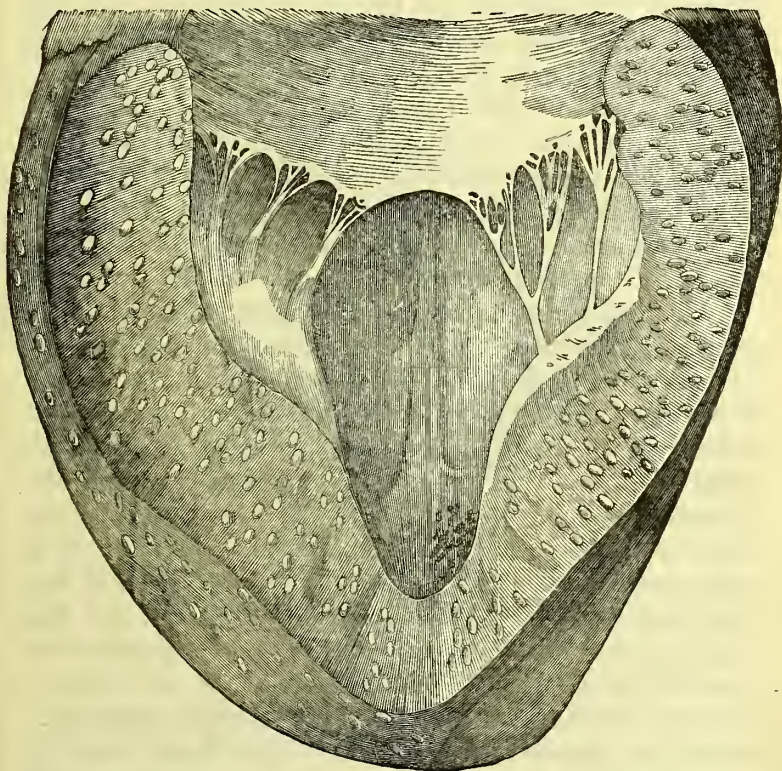


FIG. 6.—Part of the heart of a calf occupied by larvæ (*Cysticercus bovis*) of the beef-tapeworm. After Mosler. Natural size.

when he remarked that it is 'evil things that do fastest propagate.'

With these remarks on the beef tape-worm, I pass to the consideration of the pork tape-worm; but before I do so, it is as well to state a fact of practical interest. We want

to realise what is the proportion of animals containing these parasites. Of 13,818 beasts slaughtered in the Punjab during a certain year, as many as 768, that is $5\frac{1}{2}$ per cent., contained these creatures. Many delusions abound concerning the so-called pork tape-worm. If you cast your eye down the list of human entozoa, there you will see amongst the cestode parasites the *Tænia solium*, or pork tape-worm. Now the *Tænia solium*, as far as my experience goes, is comparatively rare in this country. In many hundreds of cases I have only encountered it in about 3 per cent.; 97 per cent. of such tape-worms as I have examined, human tape-worms, belong to the beef tape-worm, and come from eating underdone beef; and only 3 per cent. come from eating underdone pork. But then you must bear in mind that my experience chiefly concerns the wealthier classes of the community; for amongst the poor, who are very fond of pork, and who do not scruple to eat it in an underdone condition, the relative percentage or proportion of pork tape-worm cases is much greater than that of beef tapeworms. Still, taking one set of cases, with the other, I believe that not 25 per cent. of the whole 40,000 cases supposed to exist in London at the present moment are referable to the pork tape-worm. It is fortunate for us that the pork tape-worm is comparatively rare, for it is a dangerous parasite. No one has ever seen a larva of the beef tape-worm migrating in the human frame, but the pork tapeworm behaves very differently. I suppose we must tell the whole truth, and therefore, at the risk of exciting some alarm, I will say that the larvæ of the pork tape-worm, the *Cysticercus cellulosæ*, has a disagreeable habit of passing to the vital organs, and even to the brain itself. I have several specimens here from the human brain. They caused the death of their hosts.

Perhaps you are inclined to speculate a little here. I fancy I hear someone saying, "I can now understand why pork was forbidden to be eaten in olden times;" and certainly we may all agree with the Jewish lawgiver that the swine is an unclean beast; but it is a delusion to imagine

that swine are more infested by these parasites than cattle. In foreign countries it is just the reverse. For in the remote East, that is to say, as far east as Siberia, where Cossacks eat their meat in an underdone condition, almost everyone is a host of the tape-worm of beef. The prohibition of pork was a wise hygienic measure. I share this opinion with Küchenmeister, who in his biblical researches was aided by an eminent Hebrew scholar, M. Michël. Dr. Küchenmeister came to the conclusion that the prohibition

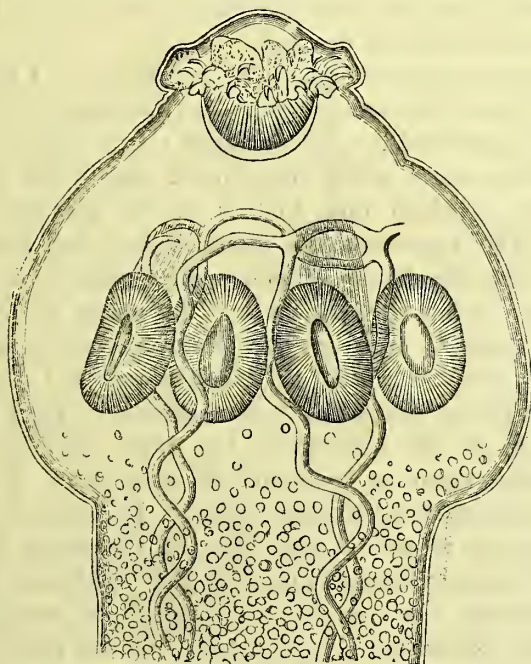


FIG. 7.—Head of the pork-tapeworm (*Tania solium*). After Van Beneden.

really depended on the fact that in eastern countries the flesh of swine had been observed to be swarming with these parasites; it is also worthy of remark that the flesh of other prohibited animals is apt to contain measles and similar parasites of this kind. The Mosaic record is valuable in many ways; and the parasite which is described by Moses as the fiery serpent figures on our list as the

Guinea worm. A most admirable description is given of the behaviour of the creature, and of the misery it produces on mankind by the production of those burning fiery pains which appear to have suggested the name. Now to pass on to another matter altogether. When you purchase a Westphalian ham, examine it to see whether or not it is swarming with parasites. A gentleman sent me part of a Westphalian ham which was so crowded with examples of *Cysticercus cellulosæ*, that you could not place the blade of a knife into any part without running two or three of the parasites through the body.

I pass on to another phase of our subject. I have said that we have two common tape worms, namely the *Tænia mediocanellata* and the *Tænia solium*; but there is a little parasitic creature, which lives inside one of our domestic pets, the common dog, that is of the greatest importance. The tape-worm in question is called the *Tænia echinococcus*, the larvæ of which infest man and animals, and are commonly known by the name of hydatids. These hydatids vary in size, from a pin's head up to that of a cricket ball, or even larger, and their prevalence is far greater in some countries than in our own. It is not uncommon for those who have their eyes about them, to encounter them in meat. I have on seven separate occasions seen measles in joints of mutton. The mutton measles is very like the *Cysticercus cellulosæ*, and a former colleague of mine at the Middlesex Hospital once brought me a mutton chop, which he was going to enjoy at a restaurant. In the centre of the chop was one of these *Cysticerci*. It is by no means uncommon for us to find hydatids in flesh served at table, and here it occurs to me to tell you that some droll experiences are occasionally encountered by those of us who work in this singular branch of biological science. Not a few have occurred to myself. During some experiments which I was making with a view of ascertaining whence these creatures came, and whither they went, I had an assistant who observed with care the facts of development of the parasites in a

dog. We had fed the dog with some hydatids, to see if we could rear any tape worms. Shortly after I observed that the attendant became very serious; and presently he said to me, "Sir, I have had my misgivings since you performed that experiment. I have had an uncomfortable feeling in the throat, and I really believe I have got, what you scientific gentlemen call the *Echinococcus*." I soon persuaded him that he was under a delusion; but that little incident was capped by another, which is certainly to the point. I was at a restaurant one day, and having ordered a plate of meat, immediately observed upon it the hydatid, which we call *Echinococcus veterinorum*, so familiar to veterinary practitioners. I said to the waiter, "Step this way, look there!"—"What is the matter, Sir?" he said. "What is the matter!" said I. Look there." He replied, "I do not see anything amiss." "Well," I added, drawing myself up, "you have brought me an *Echinococcus*." I need not dwell upon the alacrity with which the waiter and the *Echinococcus* disappeared. But I am now speaking of the *Tænia echinococcus* of the dog. This, instead of being a large cestode parasite many feet in length, is so small that I have here on a microscope slide one or two full grown creatures, measuring only a

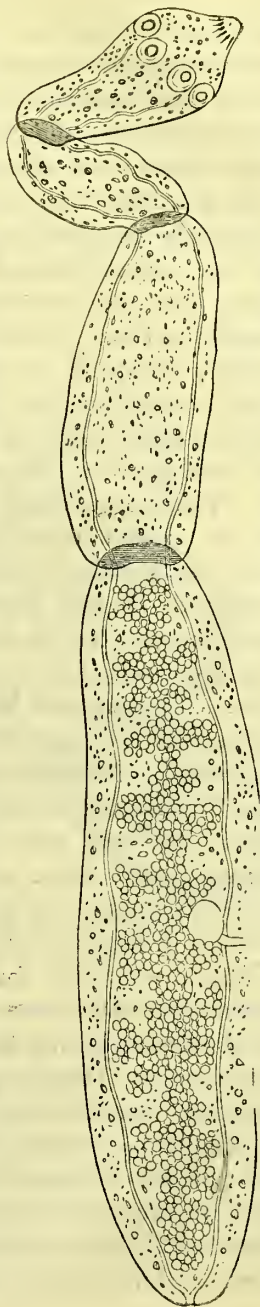


FIG. 8.—The hydatid-forming tapeworm (*Tænia echinococcus*). Original. Enlarged thirty times.

quarter of an inch in diameter from head to tail. This particular specimen was sent to me nearly thirty years ago by that eminent helminthologist, Professor Leuckart. There are nine other kinds in the dog. This worm is only a quarter of an inch in length and is very simple in its construction. It is reduced to a head, which is the uppermost zoöid, converted into an organ of anchorage, the second being a small zoöid, the third a little bigger, and the lowermost a ripe or perfect zoöid. A sexually mature zoöid when filled with eggs, contains probably 10,000 in number. Now, when a dog happens to be infested by this little parasite, wherever it goes it distributes the eggs of this parasite, in ways which I need not explain, but which must be palpable to every one. These eggs make their way amongst the herbage, and are carried about by divers agencies, wind, rain, and even insects. The grazing cattle swallow the eggs. In about three months after that—though it is pretty nearly fifteen months before the parasites are fully developed—the organs of their bodies become stuffed with juvenile hydatids. From the little eggs which have undergone digestion in the stomach of the cattle there have escaped multitudes of six-hooked embryos, and these having passed through the coats of the stomach, have at length settled down in the liver and other organs. The figures on the diagram display these vesicles in great numbers. A little lower down is the liver of a full grown hog swarming with enormous hydatids. Another figure is that of the liver of a pig which was only four months old. How did these parasites get into these creatures? They came there by the animals swallowing the eggs, which had been distributed by the dog. Those hydatids, when they are perfectly developed, contain what are called *Echinococcus* heads. The head is something like the head of an ordinary tapeworm; it has a double row of hooks, and four suckers. The heads are very numerous; you may reckon 10,000 in one hydatid. Now, supposing a dog were to swallow one of these hydatids from the liver of a pig, every one of

the heads which that hydatid contained, whether it was 1000, 10,000, or 100,000 in number, would in the course of seven weeks develop into the hydatid-forming tape worm. I have a portion of the alimentary canal of a dog, in which tens of thousands of tapeworms were reared by experiment.

Here let me remark upon a matter which should, I think, interest every one present ; from a philosophical point of view it is worth referring to. When you get an egg from a highly organised being like a chicken, you know that out

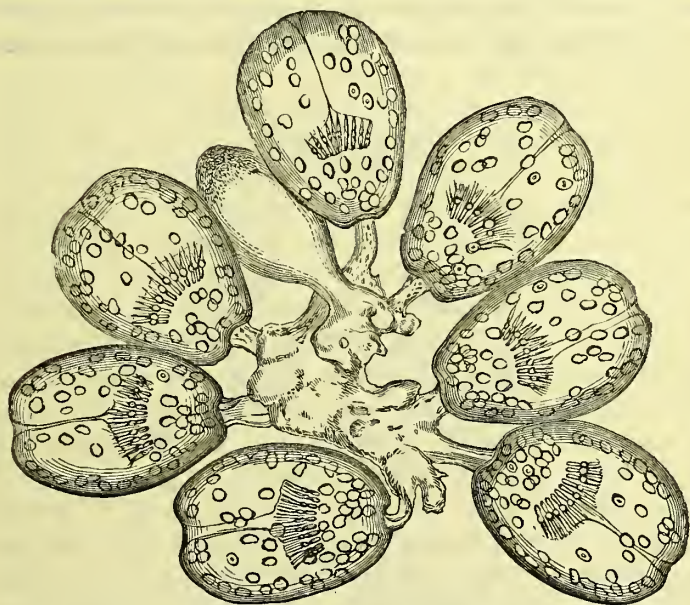


FIG. 9.—Group of Echinococcus-heads, from the interior of an hydatid.
After Busk. Magnified 250 diameters.

of that egg only one creature will come—the sum total of the products of a single egg forming what is called the zoological-individual. Babyhood, youth, manhood, and old age in ourselves are one and the same individual zoologically, although there may not be a single particle of matter now in our frames which existed when we were children. The egg of a tapeworm produces many individuals. Thus the egg of this *Tænia echinococcus* develops

into one *hydatid*, and that *hydatid* may contain 10,000 heads, and as every one of those heads is destined to become a tapeworm it follows that in place of one of those eggs producing a single individual, you may get at least 10,000 creatures.

Now there would be no *raison d'être* for our experimental labours if, by these labours we did not hope to put an end to suffering in mankind and animals. That is or ought to be the prime motive which animates us in all our work, and you will see that we have indeed a reason for this. Consider for one moment the prevalence of these parasite



FIG. 10. —Echinococcus-head, isolated. After Huxley. Magnified 500 diameters.

creatures in India and elsewhere. In India, out of 2,109 animals slaughtered at Mooltan, 899 had got these hydatid parasites, and nearly all of them occupied both the lungs and the liver; they were in the liver in 829 and in the lungs in 726 instances. Now, how is this to be accounted

flatter themselves that by not eating any meat containing these horrible creatures, they thereby save themselves from some of the many parasitic ills to which our flesh is heir. They will pardon me when I say that many of them only thus jump out of the frying-pan, as it were, into the fire; they consume vegetables which supply cellulose and protoplasm to the parasite which is of all others the most common in this country. All the harm which occurs from eating underdone meat can be avoided by the consumer; and all the harm which occurs by vegetable feeding can also be avoided if the few and simple indications afforded by the experimental researches of Perroncito, Lewis, and others are borne in mind. We have taken care to show what degrees of temperature are necessary for the destruction of parasites, whether they occur in meat or whether they occur in water or vegetables. It is of supreme importance to the community that they should have absolutely accurate and reliable information on this point. At the previous lecture I spoke to you of the low temperature at which the trichina would die, and how easy it is to avoid trichinosis. Now the fact is, that measles in pork and beef perish at a temperature of 115° Fahr.; at all events they cannot survive a temperature of 122° , if it be prolonged for one single minute. There is no excuse whatever for any one who becomes troubled by the parasites infesting meat. How is it with regard to vegetarians and water drinkers? Any one who will persist in drinking water that is not properly filtered, is liable to have the most formidable parasites invading him. A case in point, one of many within my own experience, occurred in Yorkshire. It was brought to my attention by a most amiable and cultured clergyman. In a parish it was observed that nearly all the children, and many of the grown people, were afflicted by a most formidable parasite (*Ascaris lumbricoides*). Of course, it was desirable to know how this came about, and it is now all easily explained. The inhabitants of the village used the water of a little trickling stream, which flows through the parish, for domestic pur-

poses. Into that stream ran still smaller streams, but not equally pure, from the piggeries. Now the researches of Schneider, of Berlin, have shown that the lumbricoid parasites which infest the pig are the same as those that infested the young people. The larvæ of the parasites escaped into the water; the water was used for domestic purposes unfiltered, and the consequence was that the people were attacked. It is only by the exercise of our sanitary knowledge, and by no other method that I know of, that we can escape these ills; and it behoves us as people who desire to progress, to look these facts in the face, not to say frivolously,—"Oh, parasites are horrible things, and we had better know nothing about them." It is not so. Who has not lately seen articles written in the papers about the parasites of mackerel, and what is called the "mackerel scare." Allow me to inform you that every fish is liable to contain parasites in its adult condition; the mackerel is attacked by fourteen species, twelve in its interior, and two which fasten on to its gills. If you were to swallow part of a mackerel containing hundreds and thousands of the little nematoid worms, as they are called—*Filaria piscium*—not the slightest harm would result, whether you ate the fish cooked or uncooked. There need be no scare about these fish; the slightest cooking is sufficient to kill the parasites. Permit one word of caution. I do not say there is no such thing as a dangerous parasite in any fish; but the occurrence of parasitism from this source is a matter of extreme rarity.

It only remains for me, in bringing these remarks to a conclusion, to express regret that it is barely possible for us to keep pace with our co-workers in biological science on the continent? If well meaning persons, who are not versed in the facts of parasitism, and who have not known what it is, year by year, to investigate these things, succeed in putting a stop to our experimental research, they will destroy the only possible means which we have in our power of stamping out some of the most terrible disorders which afflict man and beast throughout the inhabited globe.

And I think that they are doing the gravest wrong, who would blunt those legitimate weapons of warfare, without which weapons we cannot lay effective siege to the fortresses at present securely held by thousands of terror-creating, disease-producing, blood, brain, bone, nerve, and tissue infesting organisms. Besides, there is another phase of this question. Fanatics object to all kinds of experiments on animals, but has it not been said, and rightly said, that one human life is of more value than many sparrows—and therefore by parity of reasoning, we may add, of many cats and dogs? If thus they put a stop to our progress in science, they check one of those necessary outcomes of civilised life which establish the power and progress of a nation, and they dishonour their own country by delegating to other nations those functions, which it is our manifest duty, and I might almost say our highest prerogative, to perform.

The Chairman, in proposing a vote of thanks to Dr. Cobbold, said that when he asked him to preside on this occasion he felt it his duty, as his Parliamentary representative, to accede to the request; but he wondered why he had asked him, and he felt that probably the explanation was, that being perfectly ignorant of the whole subject, he desired to instruct him. He certainly had derived much instruction from the lecture, as must all the hearers, though at one time it had struck him for a moment on looking at their faces, that he saw reflected back the vulgar feeling that passed through his own mind at the time, namely, that with regard to some of these subjects ignorance was bliss; but then he thought of something else, far more true—that science is safety—and that it was very desirable that we should know all that we can upon these subjects with the view of relieving evils, which were so common. Many of these entozoa were only known by the eye of science; their habits, their mode of growth were known through the revelations of the microscope, and no doubt Dr. Cobbold saw in all their bodies, magnified by the eye of science, the most wonderful processes going on. If one took a Lilliputian, and

began to examine these things, you would see almost nothing. If you were to take a Brobdignagian, you would see a great deal more going on ; but with the eye of a microscope, such as Dr. Cobbold used, and, suppose a man to be magnified a thousand diameters, as he magnified the eggs of these creatures :—what would that man become ? He would be about a mile high, and some of these creatures thus magnified in the same proportion would appear to be travelling through him like enormous sea serpents. That was, speaking figuratively, what Dr. Cobbold saw with the eye of science, and it was very important that men of science should thus see what was going on, and tell the community generally what to avoid. They must have all learnt from the lecture that there were many dangers to be avoided ; but that they were, for the most part, perfectly preventible. With the knowledge which had now been communicated, he was sure they would all agree in returning a hearty vote of thanks to Dr. Cobbold for his exceedingly interesting lecture.

APPENDIX.

Special Catalogue of Drawings of Parasites exhibited on six sheets in the South Gallery; Class VIII., No. 206.

NOTE.—The source of every illustration is correctly given in this catalogue. Where no authority is quoted, the illustration is understood to be original and from nature. Most of the drawings have been executed by myself and Miss Cobbold (M. A. C.).

T. S. C.

74, Portsdown Road,
London, June 1, 1884.

SHEET NO. I.

TRICHINA AND TRICHINOSIS.

Fig. 1. Portion of trichinised flesh from a rabbit as seen under the microscope. It shows Trichinæ recently encysted, each cyst or capsule containing a single worm. From Pagenstecher. C. S. C. (in part). Magnified 400 diameters.

Fig. 2. Portion of human muscle, showing several lemon-shaped capsules that are nearly uniform in size, and completely calcified. Magnified 300 diameters.

Fig. 3. A solitary capsule from human muscle, with its contained Trichina spirally coiled. After Bristowe and Rainey. C. S. C. (in part). Magnified about 850 diameters.

Fig. 4. Two polytrichinous capsules found in American pork. The cyst to the left shows two worms, and that to the right seven worms. Drawn in one figure from separate illustrations by M. Chatin, whose examinations of infected meat were made at Havre, in April 1881. Here enlarged to about 1000 diameters.

Fig. 5. Group of abnormal Trichina capsules. Two of the cysts are united, so as to form one compound, hourglass-shaped, bilocular capsule, of which the lower division contains two worms, and the upper division three worms. One on one side of this compound cyst is a smaller, narrow, curved, spindle-shaped, unilocular capsule, containing a single worm. From American pork. After M. Chatin, Havre Laboratory, June 1881. Highly magnified.

- Fig. 6. Remarkable abnormal capsule, in outline resembling the form of a tennis bat. After M. Chatin (viande américaine).
- Fig. 7. Completely calcified *Trichina* capsule, with calcareous degeneration of the contents. After M. Chatin (viande américaine).
- Fig. 8. Young male *Trichina spiralis*. After Pagenstecher. Magnified about 1,350 diameters.
- Fig. 9. Tail of the male *Trichina*, showing the lateral lobes and projecting cloaca. After Pagenstecher. Enlarged to nearly 4,000 diameters.
- Fig. 10. Young female *Trichina spiralis*. After Pagenstecher. Enlarged about 1,700 diameters.
- Figs. 11-13. Three separate stages of embryonal growth undergone within the body of the parent worm. After Leuckart. Here magnified nearly 4,000 diameters.
- Fig. 14. A free *Trichina* embryo. After Leuckart. Magnified about 6,500 diameters.
- Fig. 15. A fully developed larval *Trichina*, removed from infested flesh. At this stage the worm already exhibits an intestinal canal, the lateral line, and the reproductive tract. After Leuckart. Magnified about 600 diameters.

SHEET No. II.

NEMATOID PARASITES INFESTING THE LUNGS OF THE SHEEP.

- Fig. 1. Section of one of the lobes of the lung of a sheep affected with parasitic bronchitis or "husk." The branches of a large bronchial tube are seen to be stuffed with entozoa (*Strongylus filaria*). Enlarged from an old drawing preserved at the Royal Veterinary College. M. A. C. Highly magnified.
- Fig. 2. *Strongylus filaria*, female. Only the anterior and posterior divisions of the body of the worm are here represented. After Alois Koch. Here magnified 150 diameters.
- Fig. 3. Tail end of a male *Strongylus filaria*, showing the hood and spicules. After Alois Koch. Enlarged about 300 diameters.
- Fig. 4. Egg of *Strongylus filaria*, containing an incompletely developed embryo. After A. Koch. Magnified about 1,500 diameters.
- Fig. 5. Embryo of *Strongylus filaria*, showing already a well formed, intestinal canal. After A. Koch. Magnified about 1,900 diameters.
- Fig. 6. *Strongylus rufescens*, male. The head and tail are here alone represented. After A. Koch. Magnified 200 diameters.

Fig. 7. Tail of the female *Strongylus rufescens*. After A. Koch. Highly magnified.

Fig. 8. *Strongylus paradoxus*. This species is readily recognised by the curious globular vesicle appended to the tail of the female worm. The anterior and posterior ends of the body are here alone represented. After A. Koch. Magnified 225 diameters.

Fig. 9. Tail of the male *Strongylus paradoxus*, showing the long and otherwise remarkable spicules, which are also fish-hook shaped at the free extremity. After A. Koch. Highly magnified.

Fig. 10. Fragment of one of the spicules (of the above) showing its external transverse markings or bands and fluted character. After A. Koch. Magnified about 1,000 diameters.

Figs. 11-14. Four eggs of *Strongylus paradoxus*, in different stages of development. The uppermost figure shows a perfectly formed intra-chorionic embryo. After A. Koch. Highly magnified.

Fig. 15. Free embryo of *Strongylus paradoxus*, with an intestinal canal. After A. Koch. Highly magnified.

Fig. 16. Free embryo of *Strongylus paradoxus*. This figure was drawn from one of numerous living specimens forwarded to me by Dr. Bantock, of Chester, Nov. 2, 1864. Magnified about 2,300 diameters. All the embryos examined at the time displayed the characteristic button-like enlargement at the end of the tail.

Fig. 17. The right lung of a sheep extensively diseased by small nematode worms, and showing externally several walnut-sized growths or tumours. There are also several smaller growths, resembling miliary tubercles. After A. Koch. M. A. C. Enlarged.

Fig. 18. Magnified representation of a very small covering-glass, beneath which one of the little worms removed from the diseased lung, above mentioned, is supposed to be placed. The little nematode, which is freely coiled upon itself, is the minute hair-worm, called *Pseudalius ovis pulmonalis* by Alois Koch. This entozoon was described by the late Dr. Edwards Crisp as a species of gordius. After A. Koch. Magnified 100 diameters.

Fig. 19. *Pseudalius ovis pulmonalis*, male. Only the upper and lower ends of the worm are here represented, magnified to the extent of *eleven thousand* diameters. After A. Koch. This minute entozoon is, from its transparency, scarcely visible to the naked eye, and when uncoiled it measures about an inch in length, its breadth being from $\frac{1}{300}$ to $\frac{1}{350}$ of an inch only. If the entire body were magnified to the extent shown in the drawing, the figure would reach the length of 90 feet.

- Fig. 20. Tail of the female *Pseudalius ovis pulmonalis*, showing the mode of termination of the intestinal tract and reproductive organs. After A. Koch. Magnified about 10,000 diameters.
- Fig. 21. Another view of the tail of the female *Pseudalius*, showing muscular and other structures. After A. Koch. Highly magnified.
- Figs. 22-23. Eggs of *Pseudalius*, one showing a micropyle at the upper pole, and the other a coiled embryo in the interior of the chorion. After Koch. Here magnified upwards of fifty thousand diameters.
- Figs. 24-27. Four representations of embryos of *Pseudalius ovis pulmonalis*, in different positions and separate stages of growth. In Fig. 24 there is a rudimentary generative organ; in Fig. 25 the remains of a cast off skin are seen; in Fig. 26 the intestinal canal is commencing to form; in Fig. 27, where only the lower half of the body is drawn, a curved hook is seen at the tip of the tail, and there is likewise a small sub-terminal spine. After A. Koch. Highly magnified.
- Fig. 28. Representation of a solitary embryo first observed and figured by me on Feb. 6, 1863. This larva, referable to *Pseudalius*, exhibited a chitinous pharynx and rudimentary intestinal tract. Highly magnified.
- Fig. 29. Calcareous remains of a dead and degenerated parent worm (*Pseudalius*), surrounded by an adventitious capsule formed within the substance of the lung. After A. Koch. Magnified about 1,150 diameters.

SHEET No. III.

THE BEEF TAPEWORM AND ITS MEASLE.

- Fig. 1. Beef tapeworm or cestode derived by man from the consumption of measled beef or veal (*Tænia mediocanellata*). In the full grown state the body or strobile consists of about 1,250 segments arranged in single file. Each perfect segment or proglottid represents a zoöid. The natural length of the worm is from 18 to 28 feet, but the lower segments are here enlarged to 3 diameters.
- Fig. 2. Head of the beef tapeworm (*Tænia mediocanellata*). It is viewed at an angle, so as to show three of the four suckers. Magnified 70 diameters.
- Fig. 3. Another representation of the head of a *Tænia mediocanellata*. The head is viewed from above, and seen to be destitute of hooks, but the figure explains the natural arrangement of the four suckers, as well as the position of the so-called

fifth or supplemental sucker. The water vessels are also displayed, though incompletely. Partly after Küchenmeister. Magnified about 230 diameters.

Fig. 4. Section of the body or strobile showing two entire proglottides and part of a third segment. Magnified 6 diameters.

Fig. 5. One proglottid, and part of two other segments, prepared to show the water-vessels, the reproductive papilla, and the general disposition of the internal organs. After Blanchard (in part). Magnified 20 diameters.

Fig. 6. Seven detached or free proglottides that have quitted the human host of their own accord. They are represented in varying degrees, either of extension or contraction, as the case may be. In these states they are frequently mistaken for separate and independent forms of parasitic life. After Leuckart (in part). Magnified 4 diameters.

Fig. 7. A perfect egg of the *Tænia mediocanellata*, showing the thick chitinous shell, and its contained six-hooked embryo or hexacanth prosclex. Magnified upwards of 6,000 diameters.

Fig. 8. The heart of a calf that had been made the subject of a feeding experiment with the mature proglottides of the beef tapeworm. The external or serous surface of the organ is seen to be studded with measles. After Mosler. Magnified.

Fig. 9. Vertical section showing the interior of the same heart, and the measles scattered throughout the substance of the muscular wall of the left ventricle. After Mosler (by Mr. Jennens). The so-called acute cestode tuberculosis thus artificially produced caused the death of the calf. Magnified.

Fig. 10. Representation of the partially dissected left hind quarter of an English calf, that was made the subject of a worm-feeding experiment in December, 1864. The surface of the *triceps adductor femoris* muscle being exposed, exhibits at the surface 120 measles, about the half of which are crowded together at the upper part. In this case the infection did not prove fatal to the animal. See Proceedings of the Royal Society, May, 1865. Enlarged from the original dissection.

Fig. 11. One of the experimentally reared measles (*Cysticercus bovis*) within its capsule, through the walls of which the head of the parasite is distinctly visible. Magnified about 60 diameters.

Fig. 12. A *Cysticercus bovis*, or beef measles, removed from its cyst, with the so-called neck and body everted. The head displays all the characteristic marks of the head of the sexually mature beef tapeworm (*Tænia mediocanellata*). It is unarmed, or destitute of hooks, but shows the spurious, central, supplementary, or fifth sucker. Magnified 65 diameters.

Fig. 13. Imperfectly developed measles, removed from the heart of the English calf above mentioned. This aborted *Cysticercus bovis* was situated within the wall of the left ventricle, some twenty other imperfectly formed measles being also present. In addition to the ordinary calcareous corpuscles, the specimen exhibits three imperfect suckers whose walls have undergone calcification. Divested of its cyst, the measles measured only $\frac{1}{14}$ of an inch. Magnified 225 diameters.

SHEET No. IV.

HYDATIDS.

- Fig. 1. The lungs and liver of a sheep infested with hydatids or echinococcus-bearing bladder worms (*Echinococcus veterinorum*). Copied from an original drawing by the late Mrs. Elizabeth Cobbold, of Holywells, Ipswich (from nature, August 9th, 1818). M. A. C. Size increased by one half.
- Fig. 2. The liver of a hog infested and much altered in shape by the presence of mature or fully-formed hydatid growths. At the upper part a parent vesicle is cut to show the daughter vesicles escaping. Copied from a drawing preserved at the Royal Veterinary College. Case published by Professor J. B. Simonds. Enlarged by one half of the natural size of the affected organ. M. A. C.
- Fig. 3. The liver of a pig studded with multitudes of immature hydatids, resembling and at first mistaken for ordinary measles. A cut at the centre of the organ shows that the vesicles are not limited to the surface. Six pigs of the same litter, four months old, were similarly affected, all of them having been sent to market and sold as food (without the livers). Drawn from a specimen sent to the Principal of the Royal Veterinary College by Mr. Thomas Olver, V.S., Truro. M. A. C. (in part). Enlarged to twice the natural size.
- Fig. 4. Illustrations of the so-called "pill-box hydatid" of John Hunter. In the figure to the right the maternal hydatid is laid open to show the daughter hydatids within, whilst two of these secondary formations are represented by the figures below. Human specimens.
- Fig. 5. A young hydatid of four weeks' growth escaping its capsule. After Leuckart. M. A. C. Magnified 300 diameters.
- Fig. 6. Immature hydatid of eight weeks' growth removed from its capsule. It exhibits the laminated, transparent, homogeneous ectoderm, inclosing the vital internal membrane or granular endoderm. M. A. C. Magnified 300 diameters.

- Fig. 7. An echinococcus head or scolex of the *Tænia echinococcus*, removed from the interior of a mature hydatid which infested the liver of a zebra that died (from an accident) at the Zoological Gardens. It shows especially the double crown of hooks, two of the four suckers, and calcareous corpuscles in the interior. After Huxley. Magnified about *three thousand* diameters.
- Fig. 8. Three echinococcus brood capsules attached to and projecting from the endodermal membrane of a mature hydatid. The capsule to the left exhibits several echinococcus heads, some everted, others inverted, whilst the investing membranes of the other two brood vesicles have collapsed, leaving the "heads" and their pedicles or stalks exposed. After Leuckart. Magnified about 200 diameters.
- Fig. 9. Group of echinococcus heads attached by their pedicles to the remains of a collapsed brood capsule. From a liver hydatid of the pig. After an original drawing by Professor George Busk, F.R.S. M. A. C. Magnified 600 diameters.
- Fig. 10. Three examples of an hydatid-forming tapeworm (*Tænia echinococcus*) of thirty-two days' growth. Reared by experiment in a dog which was fed with human hydatids. After Dr. J. D. Thomas, Adelaide, Australia. M. A. C. Magnified 100 diameters.
- Fig. 11. *Tænia echinococcus*. From a carmine-stained specimen presented to the exhibitor by Professor Leuckart. It displays the proboscis and hooks, the four cephalic suckers, the water vessels, and the three segments forming the body or strobile. The lowest segment or proglottid is mature, and therefore charged with eggs. Magnified about 300 diameters.
- Fig. 12. Two hooks removed from the head of a mature *Tænia echinococcus*. After Dr. H. Krabbe. Magnified about 3,600 diameters.

SHEET NO. V.

THE LIVER FLUKE.

- Fig. 1. Mature *Fasciola hepatica*, or liver fluke, from the sheep. The illustration shows especially the uterine rosette, the germarium, vitellarium, spermarium, and other parts of the reproductive system. After Blanchard (by Mr. Jennens). Magnified 25 diameters.
- Fig. 2. Mature *Fasciola gigantea*, from the liver ducts of a giraffe that died at Edinburgh (where it was being exhibited in 1854). The animal was "rot affected." The parasite is here seen from behind, and shows the water vessels injected with size and vermilion. Magnified 15 diameters.

- Fig. 3. Another example of *Fasciola gigantea*, viewed from the front or ventral surface. I have here injected the digestive system of the parasite with ultramarine. Coloured figures and descriptions were given in the "Edinburgh Philosophical Magazine," October, 1855. Magnified 13 diameters.
- Fig. 4. Egg of *Fasciola hepatica*, with contained ciliated larva, having its head directed towards the operculum. After Professor A. P. Thomas. Magnified 4,760 diameters.
- Fig. 5. Free swimming ciliated embryo of the common liver fluke (*Fasciola hepatica*), showing the head papilla, ectodermal nucleated cells supporting the cilia, and the so-called eye-spots. After A. P. Thomas. M. A. C. Magnified 3,500 diameters.
- Fig. 6. Free ciliated embryo in the act of penetrating the body of a small snail (*Limnea truncatula*), the tissues of which are here tinted of a yellow green. The "epaulet like cells and ciliated infundibula" are well shown (by Professor Thomas). See his memoir in the "Quarterly Journal of Microscopical Science" for January, 1883. M. A. C. Magnified 3,500 diameters.
- Fig. 7. An embryo undergoing metamorphosis within the body of a snail. After A. P. Thomas. M. A. C. Highly magnified.
- Fig. 8. Completely metamorphosed embryo, transformed into a sporocyst, here seen at a very early stage of growth. After A. P. Thomas. M. A. C. Highly magnified.
- Fig. 9. A fully developed sporocyst with numerous germs in the interior one of which, to the right, is seen in the gastrula stage of evolution. At the upper end is shown an organised nurse or redia ready to escape the sporocyst. The two degenerating eye-spots of the ciliated embryo are still visible below. After A. P. Thomas (but here reversed). M. A. C. Magnified 1,380 diameters.
- Fig. 10. A young redia, or organised nurse, taken from the body of its intermediate host. It exhibits the so-called collar and rudimentary feet, and also a powerful muscular pharynx leading to a simple digestive sac or stomach, which is "filled with the yellow remains of the liver cells of the intermediary host." After A. P. Thomas. M. A. C. Highly magnified.
- Fig. 11. A full grown redia which, in addition to the structures seen in the previous figure, displays germs in every stage of growth, one of them having grown into a daughter redia, another into a nearly perfect cercaria, and two others into incomplete cercariæ. After A. P. Thomas. M. A. C. Highly magnified.
- Fig. 12. Free cercaria, showing the long tail, oral and ventral suckers, pharynx, œsophagus, digestive tubes, and large opaque cystogenous cells, which occupy a great part of the body

substance. After A. P. Thomas. M. A. C. Highly magnified.

Figs. 13-14. Back and front view of two examples of *Limnea truncatula*. Drawn from specimens originally exhibited by me in October, 1880, and declared at that time (on Leuckart's authority) to represent specimens of the intermediary host of *Fasciola hepatica*. Professor A. P. Thomas's subsequent researches showed that this view of the relations subsisting between the mollusc in question and the liver fluke, although originally based upon a misinterpretation and upon incomplete experimental knowledge, was correct. M. A. C. Magnified 25 diameters.

SHEET No. VI.

VARIOUS FLUKES.

Fig. 1. *Fasciola Jacksoni*, from the liver of an elephant. It is viewed from behind, but shows the exserted whip-like cirrus, and also the digestive tubes, which are naturally injected with bile, blood, and débris, derived from the liver ducts of the host. This parasite causes "rot" in Indian and Burmese elephants, often proving fatal to these valuable animals. See memoir in Linnean Transactions, March, 1882. C. B. (in part). Magnified 50 diameters.

Fig. 2. *Distoma crassum*, or the large Chinese fluke. The figure shows that this human intestinal parasite is furnished with two simple and undivided digestive tubes. The reproductive organs are conspicuous, especially the vitellaria. The species is rather common in China. See Linnean Society's Journal, Zool. Div., vol. xii., 1876. Magnified 13 diameters.

Fig. 3. *Distoma sinense*, or the small Chinese fluke. The digestive tubes and organs of reproduction are well seen in this almost transparent parasite, which infests the human liver, and has been found not only in China, but also in India. The parasite was discovered by Professor McConnell (1874), from whose figure the illustration is taken. See the *Lancet*, August, 1875. Here magnified 45 diameters.

Fig. 4. *Distoma lanceolatum*, or the lesser liver fluke of ruminating animals. In this species the digestive tubes are short, the vitellaria are remarkably small and narrow, but the uterine coils pass downward to the tail. This worm has been thrice observed in man. After M. Blanchard. Magnified 55 diameters.

Fig. 5. *Distoma heterophyes*, or the dwarf fluke of Egypt. This parasite infests the human intestine, and is distinguished by

its minute size, and by the presence of a fish basket-like disk situated on one side of the large ventral sucker. It was discovered by Bilharz at Cairo, in 1851, and has only once since been re-obtained. Drawn from a specimen given to the exhibitor by Professor Leuckart. Magnified 260 diameters.

Fig. 6. *Distoma lancea*. This fluke infests the liver of the dolphin of the Amazon (*Delphinus tachuschi*), and it has been obtained by Dr. John Anderson from the short snouted dolphin of the Ganges (*Orcella brevirostris*). The present figure is copied from Diesing. M. A. C. Magnified about 90 diameters.

Fig. 7. *Distoma campula*. This small liver fluke infests the porpoise (*Delphinus phocaena*), being first discovered by me in April, 1855. It has since been found by Dr. J. Anderson in the dolphin of the Ganges (*Platanista gangetica*). In the porpoise (shot by the late Mr. Jardine Murray in the Firth of Forth) it had produced a diseased condition of the liver ducts (true "rot"). See Linnean Transactions, 1856 and 1876. Magnified 90 diameters.

Fig. 8. *Bilharzia hæmatobia*. This remarkable parasite was discovered by Dr. Bilharz, at Cairo, in 1851. It infests the portal vein and blood vessels of man, and probably of monkeys. I found it in a *Cercopithecus fuliginosus*, which died at the Zoological Gardens. A similar parasite has since been discovered by Dr. Sonsino in the ox and sheep (*Bilharzia crassa*, Sons.). In this genus of flukes the sexes are distinct, the female being occasionally found (dwelling parasitically, as it were) within a gynæcophoric canal, with which, as shown in the drawing, the male is furnished. After Leuckart. Here magnified about 125 diameters.

Fig. 9. *Diplozoon paradoxum*. In this singular genus, in which the sexes are double, two originally free and immature hermaphroditic individuals become united, by means of hooks, back to back, the union subsequently becoming complete organically, so as to form a single compound individual. In this state the parasite is found on the gills of various freshwater fishes. After Von Nordmann. Magnified about 100 diameters.

Fig. 10. *Amphistoma papillatum*. This fluke infests the large intestines of the Indian elephant. It is easily recognized by the fungiform papillæ lining the interior of the ventral sucker. Such parasites are called "masuri" in India, and they prove injurious to their hosts. See Linnean Society's Transactions, 1882. Magnified 90 diameters.

Fig. 11. *Tristoma coccineum*. In this curious genus of ectoparasitic trematode worms, there are three sucking disks, two small

ones at the head, and a large one near the tail. The digestive tract appears in the form of a simple closed circular intestine. Partly from Blanchard, and partly from a specimen found on a sun-fish (*Orthogoriscus mola*) captured in the Firth of Forth. It is of frequent occurrence of the gills of the sword-fish (*Xiphias*). Magnified about 15 diameters.

- Fig. 12. *Monostoma verrucosum*, showing especially the water-vascular system. This fluke infests the cæca and large intestine of various water birds. After Blanchard. Magnified about 110 diameters.
- Fig. 13. *Brachylæmus erinacei*. Infests the intestine of the hedgehog. This fluke is probably identical with the *Distoma linguæforme* of Dr. von Linstow. After Blanchard ("Annales des Sciences Naturelles," 1847. Highly magnified.
- Fig. 14. *Polystoma intergerrimum*, showing especially the branched digestive tract and water-vessels. This species infests the urinary bladder of the frog (*Rana temporaria*). After Blanchard. Magnified about 80 diameters.
- Fig. 15. *Aspidogaster conchicolor*, from the pericardial chambers of the common freshwater mussel (*Anodonta anatina*). This fluke displays a remarkably complete ventral sucker, elliptic in form, of great size, and furnished with partitions presenting a tessellated appearance. After Pagenstecher. Here magnified about 200 diameters.

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